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11. SUPPLEMENTARY NOTES

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13. ABSTRACT (Maximum 200 words)

We have investigated the use of optically dark states for quantum information processing. We have developed a systematic theoretical approach relating atomic dark states to decoherence-free subspaces and have shown that single qubit manipulations on such dark states are possible to realize with realistic pulse times. We have found a multi-atom dark state in N-atom/cavity systems that can be used to develop an adiabatic ramping scheme to produce N-photon states on demand.

14. SUBJECT TERMS **dark states** **decoherence-free subspaces** **atom-cavity systems** **optical lattices**	15. NUMBER OF PAGES **2** 16. PRICE CODE

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Final Progress Report

Statement of Problem Studied

The aim of this project was to develop theoretical methods to take advantage of optically dark atomic states for quantum information processing. One focus was on establishing the relationship between such atomic dark states and decoherence-free subspaces, and providing a systematic route to the former. Another focus was on developing ways to manipulate such dark states for quantum logic and related processing. The third focus was to develop a quantum wave function approach for simulation of coupled qubits.

Summary of Significant Results

1. Establishment of a systematic theory for atomic dark states in terms of decoherence-free subspace theory. This allows a simple and systematic approach to determine the existence of, to search for, and to identify dark states in atomic systems.
2. Development of procedure for one-qubit operations on atomic dark states within finite time pulses.
3. Identification of new N-atom dark states that can be manipulated by adiabatic rampling schemes to allow deterministic production of N-photon Fock states from an N-atom/cavity system.
4. Development of efficient quantum wave function approach for simulation of coupled qubit arrays and implementation in algorithmic fidelity study of 9 coupled qubits with a 3-qubit encoding.

List of Publications

D. M. Bacon, Ph.D. Thesis, University of California, Berkeley, (2001)
“Decoherence, Control and Symmetry in Quantum Computers”

D. M. Bacon and K. B. Whaley, “Qubit operations on atomic dark states,” manuscript in preparation

K. Brown, K. Dani, D. M. Stamper-Kurn, and K. B. Whaley, “Deterministic Fock State Generation,” to be submitted to *Physical Review B*

S. Myrgren and K. B. Whaley, “Implementing a quantum algorithm with exchange-coupled quantum dots: A feasibility study,” manuscript in preparation

List of Participating Scientific Personnel and Degrees Earned

K. Birgitta Whaley, Professor
David Bacon, graduate student (Ph.D. 2001)
Simon Myrgren, graduate student
Keshav Dani, graduate student
Kenneth Brown, graduate student
Dan M. Stamper-Kurn, Professor

Report of Inventions

N/A

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Manipulating Optically Dark States for Quantum Logic

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Sincerely,

Birgitta Whaley